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ABSTRACT

Environmental education activities of some Washington-based, professional science-oriented organizations and federal agencies concerned with environmental improvement are described in this newsletter. Its purpose is to acquaint persons with the activities of representative environmental concern groups in the nation's capital, since a substantial part of the efforts to environmental education problems is generated or brought together in summary fashion in Washington, D.C. Mention is made of defining environmental education, perception of environmental problems and analyses of them, development of curriculum guidelines, bibliographies, and data banks, training of teachers through workshops, seminars, institutes, conferences, etc., preparing materials for creating environmental awareness, production of audio-visual aids, journals dealing with environmental problems, financial support of programs and projects of an environmental nature, contributions of conservation organizations, establishment of college and community development courses, and environmental legislation, both federal and state. Names and addresses of organizations cited are included for those who wish additional information. (EL)

SCIENCE FOR SOCIETY
Education Review
Commission on Science Education

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Vol. 1, No. 2 March, 1971

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Washington Activity on the Environmental Education Front

It would be impossible to defend the proposition that all efforts to meet environmental education problems have their origin in the Nation's capital. Countless projects have found their inspiration at state and local levels and in many instances are being conducted in effective fashion without dependence on any Washington office, governmental or otherwise. Development of Environmental Science Education Councils and their activities, highlighted in the first issue of *Education Review*, clearly demonstrate the strength of this widespread movement.

It is worthy of note, however, that a substantial part of the work is generated or brought together in summary fashion in Washington. The reasons are obvious. Many professional science-oriented organizations have their main headquarters there; so do those federal agencies concerned with environmental improvement. It may be of interest, therefore, to indicate what some Washington-based, representative groups (it would be futile to attempt a complete round-up) are doing in this field which now commands such overwhelming attention.

Basic Considerations

The responsibilities shouldered by these groups range from the comprehensive to the specific. The Task Force on Environmental Education, National Education Association (NEA), has been charged with development of guidelines for appropriate curriculums for use in the schools from kindergarten through adult education. What challenge could have a wider sweep?

In contemplating any activity, an interested organization must develop its own definition of the environment. Generally accepted definitions are hard to come by; most are made to fit special interests and available resources. Partly to clarify their own thinking along these lines and partly to contribute to the thinking of their constituents, a few groups have assembled papers containing helpful clues. The U.S. Office of Education, HEW (USOE), for example has issued "Readings in Environmental Awareness—A Selection of Concept Papers"; the National Science Teachers Association (NSTA) has acted similarly by publishing "Vital Views of the Environment," excerpts from statements made by outstanding scientists and educators.

Definition is essential, but it is only the beginning. In order to make contributions of value and distinctiveness, it is vital to determine what others are planning or actually have in operation. Once again, a USOE publication, "EE-Environmental Education—Education That Cannot Wait," offers an analysis of problems and programs (K-12) for solving them. NSTA has moved similarly in its "Environmental Programs in Education," featuring distinctive activities of merit in each of the 50 states.

Scanning the Field

The vast outpouring of literature from every conceivable source has led to the rapid but all too quickly outdated publication of bibliographies. Recognizing the pace at which new materials are issued, AAAS is making available an updated and much enlarged edition of its "Science for Society" compendium; the Massachusetts Audubon Society, with USOE support, earlier issued an "Environmental Education Bibliography" in three sections (Preschool-Grade 3, Grades 4-6, and Grades 7-9). The NSTA has produced another bibliography on the elementary and secondary school level entitled "Environmental Education for Everyone." Helpful to the diligent researcher are such basic materials as the American Association of University Women's (AAUW) "A Resource Guide on Pollution Control—Federal, State and Local Agencies and Organizations That Deal With Environmental Problems" and "A Survey of Environmental Science Organizations in the U.S." edited by Wang and Belter, Environmental Sciences Institute, San Jose, California. The American Society for Engineering Education (ASEE) has published a college student's guide to literature on environmental science engineering. Even the Washington-based American Institute of Architects has shown considerable interest in the area and has distributed a comprehensive survey of programs and materials dealing with the man-made environment.

So prolific has become the production of reading materials that some organizations are considering depositing information about them in data banks. The American Geological Institute (AGI) already has done this and has set up the GEO-REF series, one category of which deals with environmental geology.

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Of all efforts to compile, analyze, and disseminate environmental education information the most comprehensive is probably that of the ERIC Center for Science and Mathematics Education. ERIC is a widely known information system established by USOE with headquarters in Columbus, Ohio. Its Center is currently surveying the environmental education field preparatory to making available EE activities listings of every kind and description.

Keeping Up-To-Date

One of the best ways an educator has for keeping current with constantly changing new developments is to study the regularly issued national journals, some general, some specialized. AAAS's *Science* often presents articles on various environmental topics. The American Chemical Society's (ACS) "Environmental Science and Technology," while directed primarily to research workers and other experts, gives a running account of advances in the field. The monthly "Sierra Club Bulletin" provides general articles, photos and a Washington Report on environmental subjects. "Environment," published ten times a year by the Committee for Environmental Information, draws attention to pollution and misuse of the environment. The National Association of Biology Teachers' (NABT) journal, "The American Biology Teacher," contains frequent environmental articles as do "The Science Teacher" and "Science and Children" (elementary school level) of NSTA. The American Institute of Biological Sciences' (AIBS) "Bioscience" does the same; and the January 1971 issue of "Social Education", the publication of the National Council for the Social Studies (NCSS) is almost entirely devoted to the subject. ASEE's "Engineering Education" for November 1969 was devoted to the environment and other issues contain additional references.

There seems to be little agreement in Washington on whether it is better to prepare wholly new environmental courses or to incorporate the new knowledge into existing curricula. Circumstances determine the decision; the main point on which all agree is that the job must be done. Significant also is the unanimous view that no development in this generation has done more than environmental concern to spur interdisciplinary programs.

Teaching the Teachers

Virtually every organization has recognized the urgency of training teachers for the task ahead. Prior to its March 1970 meeting NSTA staged a two-day workshop based on this theme. In AIBS' 1970-71 Visiting Biologists Program, high-school teachers and administrators become acquainted with distinguished scientists in the life sciences and hear their lectures on environmental topics presented in many centers. Through its Earth Science Teacher Preparation Project as well as its Environmental Studies

Teachers at a TETE Workshop learn about on-site investigations. Regarding the miniplot staked out here, William Eblen, TETE Director, is asking, "Can you image the difference between what this plot contains and what a similar sized plot in a city lot would contain?"

for Urban Youth (both actually conducted out of Boulder, Colorado), the AGI is pioneering new approaches and preparing new materials for creating environmental awareness. These are currently being tested in classrooms in pilot projects in 12 urban areas.

Although NABT does not profess to have specific plans along environmental education lines (after all, it contends, biology instruction in its very nature has long been involved in the subject), two of its three-day 1970 Regional Seminars in Biology were devoted to topics on pollution.

The Federal Government has helped to finance several of the undertakings mentioned, and many more. USOE's Manpower and Training Division, along with the Environmental Health Service, HEW, and the Water Quality and Manpower Administrations of the Interior Department, sponsored three-day Environmental Teach-Ins in late 1970 and early 1971. Objectives were to define problems and "manpower solutions" with special attention to disadvantaged youth. Typical of wide-scale programs financed by USOE is Total Education in the Total Environment, Inc. (TETE) headquartered in Norwalk, Conn. and designed to foster school and community activities. Typical users of the TETE Program services are the State Departments of Education of Connecticut, Colorado, New Hampshire; the Association for Supervision and Curriculum Development; and the Joint Council on Economic Education. NASA has collaborated with ASEE on a summer institute program for engineering college teachers, some of which are devoted to problems on the environment.

Fortified with new Congressional appropriations, USOE has now embarked on an expanded "Guidelines" program including experimental workshops, seminars and research activities for teachers and students at K-12 levels.

NSF, deluged with hundreds of proposals for support of projects of an environmental nature, approved 29 in December 1970 for advancing the inservice training of high-school science and mathematics teachers and supervisors. The conferences, to be held

during the summer and lasting up to four weeks, will be held primarily on college and university campuses and involve over 1000 participants. At Vanderbilt University, teachers will learn about problems of drug abuse; at the University of Cincinnati, they will study population growth problems; and in the Boston and Philadelphia areas they will examine a problem-solving approach to water pollution at Tilton School, Tilton, N.H. At Stanford University leadership training will be provided for teachers in ways to stimulate high-school student interest in science and environmental problems.

Three conferences—at Michigan State University, East Lansing; University of Colorado, Boulder; and Wisconsin State University, Superior—will train high-school teachers and supervisors in conducting inservice projects for elementary school personnel.

Films and Filmstrips

Understandably, because of the time required to prepare effective audio-visual aids, only a limited number are now available. However, NEA has produced several sound-and-color filmstrips for junior and senior high schools. One filmstrip, "Man and His Environment—A New Approach to Environmental Education," has been produced by the Association of Classroom Teachers (ACT) of the National Education Association in cooperation with Project Man's Environment, American Association for Health, Physical Education, and Recreation; the National Park Service of the U.S. Department of the Interior; and the National Environmental Study Area Program. Another filmstrip, "Environmental Crisis—What the Individual Can Do," has been prepared by the Student National Education Association with the assistance of ACT, the Association of Supervision and Curriculum Development, Future Teachers of America, National Council for the Social Studies, National Science Teachers Association, and NEA Publications Division.

Consideration is being given in several quarters to the need for producing additional audio-visual materials. For example, ACS, AGI, AIBS, NSTA, NCSS and the American Society for Engineering Education (ASEE) are discussing the possibility of jointly preparing a series of multi-media aids for grades 6-8. Much is in the wind in this area, as well as in the field of broadcasting. It should be noted, however, that a most ambitious project of this nature, developed by the Public Broadcasting Environment Center as a product of a USOE grant, will not be executed. It is likely, however, that the comprehensive report of PBEC will be made available, on request, this coming summer from ERIC.

In a school program, these young fishermen learn first hand how pollution has spoiled their sport. A "still" photo from the sound-and-color filmstrip "Man and His Environment."

Some groups are undertaking comprehensive activities of a quite different nature. The American Industrial Arts Association (AIAA), national affiliate of NEA, recently embarked on a two-year project for holding eight regional forums involving the organized resources of society. Participants are asked to examine the promises and problems of technology as they relate to man and his environment, with the focus on improvement of industrial arts programs and teacher education in that field. "Many educators," says AIAA "rely on industrial arts education in the elementary schools as the best means of relieving some of our nation's frustrations in manpower development. Schools are supporting industrial arts programs in the lower grades because they afford the opportunity to teach occupational information and to develop technical literacy about our world. Labor, industrial and governmental groups would provide additional input for these programs to make them more effective in reflecting the world of technology to children."

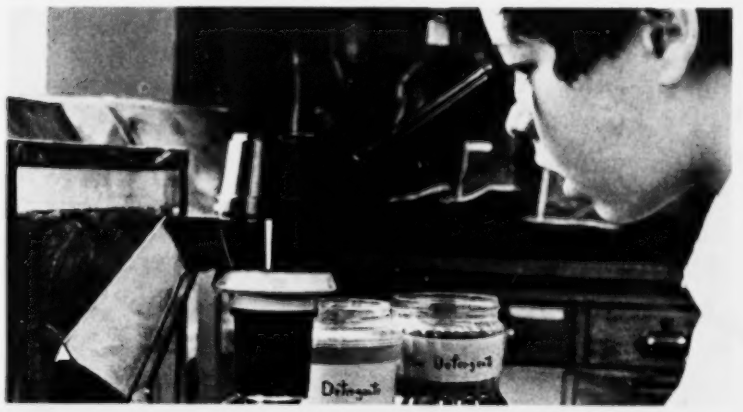
An ambitious project, soon to be initiated, is NSTA's three-stage, three-year, nationwide program, the first year being devoted to research into student, teacher and parent (adult layman) perceptions of environmental problems and possible recommendations; the second to environmental symposia; and the third to development of student, teacher, and adult teaching and learning materials.

All these aids total up to a gigantic contribution to the training of teachers of science, social science, and other courses. The avalanche will become even more enormous in the months ahead. Among printed materials scheduled to come off the press will be a series of study guides on problems of science and society proposed by the AAAS Commission on Science Education. Experts from several fields constitute the writing groups and their manuals will first be tested in inservice institutes for high-school instructors. Close to completion is a guide on air pollution, to be followed by others on population; soil pollution; peace; agriculture; food and nutrition; medicine, health and drugs; and science, technology and society. Each group preparing a guide in cooperation with the Commission obtains its own support.

Role of Conservation Organizations

For years, numerous conservation organizations

have published and distributed an abundance of encyclopedic materials on natural resource management. Although large quantities have gone to educators, the producers are newly aware of the significant role they can play if major attention is given to designing their publications *specifically* for school use. The National Wildlife Federation, for one, is developing a series of short, simple, self-contained units for classroom teachers who have no particular background in environmental studies. Every academic subject and level will be covered by these units, available by September, 1971. The Conservation Foundation, for another, is giving serious consideration to projects at the junior-high, senior-high and university levels. The program may be started with the production of supplementary materials whose primary use would be in social studies classes but could be helpful in other courses as well.



What's all this furore about detergents? Rod Crusher, a student at Arlington Jr. High School, Poughkeepsie, N.Y. studies the problem for himself—an activity in the Hudson River Museum's Total Education in the Total Environment Project.

A Glance at the Colleges

Although this issue of *Science for Society—Education Review* concentrates on environmental activity at K-12 levels, work in the colleges is found to affect teaching generally and therefore merits attention here. Many institutions have established courses and entire programs in the area. The University of Wisconsin at Green Bay is well known for its comprehensive and progressive devotion to environmental studies. At some colleges and universities, titles of courses involving such training often disguise their actual content. This is true of the AAAS Chautauqua-Type Short Courses for College Teachers, soon to be expanded, with NSF support, from the pilot stage so as to involve approximately 2,000 participants in the 1971-72 program. More apparent by title are other short courses like AGI's "Environmental Geology Short Course" and ACS's "Biological Degradation of Municipal and Industrial Wastes," to name but two. Several community-wide environmental programs centered at colleges, including those at Clarion State College (Pa.) and at Cuyahoga Community College (Ohio), were described in the December issue of AAAS's *Science Education News.* In colleges of engineering there are now baccalaureate curricula which are accredited, and some 25 which offer graduate degrees specifically involving the environment in their titles.

Enlisting Society Membership Support

Some national societies have designed activities to encourage active engagement of members in practical and useful environmental improvement work in their localities. They have sought to alert their members to the needs and opportunities through a variety of approaches. At its 1970 national meeting the ACS presented a symposium on environmental improvement, featuring Barry Commoner, Washington University; Herbert D. Doan, President, The Dow Chemical Company; Lee A. DuBridge, former Presidential Science Advisor; and Lloyd M. Cooke, Union Carbide Corporation. Highlights of that symposium have been made available both on tape and film. Another example of this type of "missionary" work is that of AGI whose Council on Education in the Geological Sciences (CEGS) is sponsoring environmental education in its 1970-71 Professional Development Program. Still another example—ASEE has an environmental engineering division comprised of about 1,000 engineering and technology teachers and sponsors a series of conferences at the Society's annual meetings.

Federal Assistance

Throughout the foregoing discussion occasional references have been made to support given various projects by the national government. Although this issue is largely devoted to activities of Washington-based groups, there may be justification for sketching ways in which a single representative undertaking, based elsewhere, has been executed with the support of the Federal government. With this assistance, the Biological Sciences Curriculum Study (BSCS), headquartered in Boulder, Colorado, has engaged in a number of programs concerning the problems of science and society and designed for teachers, students and laymen. These projects include: (1) A partially completed module for instruction, *Investigating Your Environment,* innovatively designed for two to six weeks of high-school instruction, and developed with a grant from the Division of Comprehensive and Vocational Education, Bureau of Research, USOE; (2) Production of two provocative films, "The Tragedy of the Commons" and "An Interview with Garrett Hardin," both with teacher's guides, that seek to stimulate discussion of a wide range of environmental issues, (3) A 1970 summer conference, with NSF support, of 15 teacher pairs (biology and social science from the same schools) at which interdisciplinary work was studied. Participants will return this summer to formulate guidelines for such activity, and (4) Production of a series of books (three now available)

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for citizens whose formal education does not extend beyond high school. Two major thrusts for the series: (a) topics addressing themselves to the immediate as well as continuing and pervasive problems of society for which biology has both information and a message, and (b) topics of a similar interest in biology *per se.*

Keeping an Eye on Legislation

Washington is a strategic vantage point from which to follow trends in environmental legislation, federal and state. Professional and private organizations watch both carefully. In the nation's capital they study and report on Congressional activity and not infrequently their representatives appear before committees to urge adoption, amendment or rejection of measures of special interest to them. A pertinent example of influencing decisions—conservation organizations were effective in passage of the 1970 Environmental Education Act and its subsequent funding (not adequate, they claim) to initiate its administration. Through testimony at public hearings and through information furnished to their constituencies, nationwide, they built up grass-roots pressure on Congress and the administration.

Despite these activities and those of other groups, some organizations feel that legislation on the federal level has not been too impressive thus far. They point out that only two measures to strengthen environmental education were enacted by the 91st Congress. One was the Environmental Education Act of 1970 which authorized $5 million for development of innovative approaches to problems through establishment of projects, most to be administered by USOE and conducted in various centers around the country. Of the $5 million only $2 million—to provide money for the balance of the fiscal year—has been funded. The other measure—the Youth Conservation Corps Act—authorized up to $3.5 annually to establish a joint three-year pilot program within the Departments of the Interior and of Agriculture. Somewhat reminiscent of the Civilian Conservation Corps program of the Great Depression days, it calls for summer employment of young people to help improve the environment through proper practices. Once again, this is a measure that has not yet been funded.

Nevertheless, much good work is being done at the federal level and more is being planned—all within the framework of existing legislation. It is not paucity of new legislation that bothers most observers. Rather, it is the fact that there has been to date such limited funding of measures already on the books.

Insofar as state legislation is concerned, there is not necessarily any uniformity in types of support on in relative funding although there have been moves in those directions. At a recent Southern Governors Conference a regional council was established to formulate plans for an interstate compact on the environment in which the respective state governments, non-education departments, and unofficial groups would all play a part.

Genuine concern is felt throughout state administrations about environmental problems, as shown by results of a 1970 poll on State Environmental Concerns and Priorities conducted under auspices of the National Governors Conference Committee on Natural Resources and Environmental Management. In responding to a question as to factors responsible for the "critical problems" confronted in the environmental field, the states reported that "lack of motivation and concern by the public as a whole . . . including insufficiencies of information and education" was second only to lack of funds.

Policy positions adopted at last year's National Governors Conference included a section headed "More Relevant Educational Efforts in Environment Conservation and Population are Needed." Its closing sentence declares that "states should require a constant updating of educational curricula" in these areas. The overall concern about environmental problems has prompted the Council of State Governments to include the subject in its continuing series of seminars for state officials. Additional information about these seminars may be obtained from Mr. John Fjelstaat at the Council's Lexington office, Iron Works Pike, Lexington, Kentucky 40505.

SOURCES

Readers who wish additional information about activities of organizations mentioned in this issue may contact them at the following addresses. Many of the groups have environmental source materials available on either a complimentary or charge basis. Suggestion: Mark the envelope *Environmental Education Information.*

American Association for the Advancement of Science
1515 Massachusetts Avenue, N.W.
Washington, D.C. 20005

American Assciation of University Women
2410 Virginia Avenue, N.W.
Washington, D.C. 20006

American Chemical Society
1155 Sixteenth Street, N.W.
Washington, D.C. 20036

American Geological Institute
2201 M Street, N.W.
Washington, D.C. 20037

American Industrial Arts Association
1201 Sixteenth Street
Washington, D.C. 20036

American Institute of Biological Sciences
3900 Wisconsin Avenue, N.W.
Washington, D.C. 20016

American Society for Engineering Education
1 Dupont Circle, N.W.
Washington, D.C. 20036

American Institute of Architects
1735 Massachusetts Avenue, N.W.
Washington, D.C. 20036

Association of Classroom Teachers, NEA,
1201 Sixteenth Street, N.W.
Washington, D.C. 20036

Biological Sciences Curriculum Study
University of Colorado
P.O. Box 930
Boulder, Colorado 80302

Committee on Environmental Information
138 N. Skinker Boulevard
St. Louis, Missouri 63130

The Conservation Foundation
1717 Massachusetts Avenue, N.W.
Washington, D.C. 20036

Council on Education in the Geological Sciences
2201 M Street, N.W.
Washington, D.C. 20036

Council of State Governments
1735 DeSales Street, N.W.
Washington, D.C. 20036

Earth Science Education Program
Box 1559
Boulder, Colorado 80302

ERIC Information Analysis Center for Science and Mathematics Education
1460 West Lane Avenue
Columbus, Ohio 43221

National Association of Biology Teachers
1420 N Street, N.W.
Washington, D.C. 20005

National Council for the Social Studies
1201 Sixteenth Street, N.W.
Washington, D.C. 20036

National Education Association
1201 Sixteenth Street, N.W.
Washington, D.C. 20036

National Park Service
C between 18th and 19th Streets, N.W.
Washington, D.C. 20006

National Science Foundation
1800 G Street, N.W.
Washington, D.C. 20006

National Science Teachers Association
1201 Sixteenth Street, N.W.
Washington, D.C. 20036

National Wildlife Federation
1412 Sixteenth Street, N.W.
Washington, D.C. 20036

Sierra Club
1050 Mills Tower,
San Francisco, California 94104

Total Education in the Total Environment
15 West Washington Street, Box 423
Norwalk, Connecticut 06856

U.S. Office of Education
GSA Building
7th and D Streets, S.W.
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U.S. Office of Education,
HEW, Environmental Task Force
Room 3600, ROB—3
7th and D Street S.W. Washington, D.C. 20202

A New Look at Physics Courses

Fast-changing developments affecting science and society are exerting strong pressures on every phase of education. In no field are those pressures more pronounced than in physics. To indicate ways in which leaders in that profession are attempting to deal with their problems, Science for Society—Education Review *is pleased to present the following article by John M. Fowler, Director, Commission on College Physics. It is reprinted, in somewhat abbreviated form, from the Commission's February 1971* Newsletter.

'Earth Day" has come and gone and its placards have rotted away faster than the cans that still litter our roadside. But it is not forgotten, for now, nine months later, we see in our course catalogs many courses with "environment" in their title or intent. Since this is a new focus if, at present for physics education, a minor one, I want to use this article to examine the goals and methods of a few of these courses and to make some general statements about the usefulness of this theme in physics education. Most importantly, I hope with this article to begin a more complete collection of physics courses organized around this theme.

I have said that this is a minor focus for physics. Out of the ninety or so undergraduate courses on environmental themes listed in the recent bibliography *Environmental Education in 1970*[1], only six were given in physics departments and most of these were seminars rather than courses. Three of them were seminars on "Science and Society," a title which is growing in popularity and which covers a multitude of topics.

[1] *Environmental Education 1970*, Hafner, Fowler, and Williams, Scientists Institute for Public Information, 30 E. 68th Street, New York, New York 10021.

It is my belief that the environmental theme will grow in importance in physics education in the next few years. This growth will, in part, be stimulated by self interest. Physics teachers are becoming aware of considerable consumer resistance to our earlier line of "introductory" wares and, as the present trends toward reduction of requirements continue, there will be less and less pressure forcing general students into these courses. With college and university administrators becoming more sensitive to the unit cost of education, physics will have to find some way to compete with the large enrollment in astronomy and geology courses for their share of the general student market. Environment is a "relevant" theme.

But it is also important in its own right. We really have fouled up our environment; you have all heard the statistics and seen the atrocity pictures. We are now well into what must become the period of turnaround when we begin to undo some of the harm we have done and to control both our waste output and our insatiable appetite for energy and raw materials. Many, though not all, of the questions involved have scientific components, and it is proper that physicists concern themselves with them. And they have.

Marvin Goldberger, in his article "How Physicists Can Contribute" in the December '70 "Environmental Issue" of *Physics Today*, has mentioned three ways: directly through research, through the training of environmental scientists and through an "operations research" team approach at the problem-oriented centers which he envisions.

But I believe that physics educators can contribute in a fourth way, within the liberal arts tradition, by hanging the scientific education of non-scientists on the environmental theme and thus providing a decision-making public with some awareness of both the

scientific approach to problems and the complexity of the environment.

The most popular approach to the non-scientist has been through some variation on the "Science and Society" seminar. An example of one such seminar is provided by Prof. George Reynolds at Princeton. Its scope and emphasis can be seen in the list of lecture topics below:

1. History of Air Pollution; Concerns and Relations to General Environmental Problems.
2. Legislative Framework with which Air Management is Attempted (Clear Air Act of 1967 and pending Air Quality Act of 1970 are analyzed)
3. Nature and Sources of Air Pollution
4. Effects of Air Pollution
5. Atmospheric Reactions
6. Meteorology of Air Pollution
7. Monitoring and Surveillance
8. Control and Abatement

The second half of the semester is given over to student papers on such specific topics as "Environmental Effects of Electric Power Generating Systems" and "Effect of SO_2 on Leaves."

The seminar approach is a useful one and can provide an exciting way of synthesizing and applying the students' previous course work. I have no doubt that many such seminars are presently being given or proposed. I have, for instance, seen the proposal for a student-faculty seminar, "Energy and Man," by Robert Williams of the University of Michigan's physics department and have seen the reading list for two "Honors" seminars, "Social and Ecological Implications of Modern Technology" by Langden Crane and "Problems of a Technological Society" by Leonard Rodberg at the University of Maryland. But seminars are in some ways supplmentary in higher education, at least at the large universities where much of the students' time is spent in large courses and often in courses required of them rather than sought out by them. I believe that the environmental theme has a potential central role in undergraduate education.

To define this role it seems to me that we must go back and ask again the question, "Why do we require physical science courses?" and then, from the answers we give, design our course on the environment. This is a much different way of proceeding than I see behind most environmental courses and seminars. For most of these the question is "What is wrong with our environment?" or "What can we do to restore our environment?" (or both). I see the strongest use of environment as an organizing theme for the concepts, principles, and experiences of physical science that we feel our students should have. It has certain definite advantages as a theme; it is integrative, bringing together many different areas of science, and it is a theme which has much student appeal.

There are existing examples of courses which use the environmental theme in this way. Edwin Marston of Queens College has reported one such course in the *American Journal of Physics.*[2] Tony Jensen is teaching an interesting variation on the same theme to business students at the Wharton School of the University of Pennsylvania. The major topics for the first semester are:

I. Introduction (Environment and Measurement)
II. Kinetic Energy (Motion and Transportation)
III. Thermal Energy (Heat and Steam Engine)
IV. Potential Energy: Gravitational (Hydroelectric Power), Nuclear (Fission and Fusion), Chemical (The Automobile)
V. Electrical Energy (Motors and Electric Power)
VI. Biological Energy (The Human Brain)
VII. Electromagnetic Energy (Communication)

One can see in this list much more than enough fundamental content; the laws of motion, work, power, energy, efficiency, heat and thermodynamics, electricity and magnetism all appear in some form. But what is important is that they are not introduced in an *ad hoc* way, but as answers to questions which are being asked today. It seems more natural, somehow, to learn about acceleration and velocity in the context of planning a rapid transit system for the San Francisco Bay area than to learn about them in the abstract.

Marc Ross at the University of Michigan has carried

[2]Marston, E. H. "A Course on the Physics of Urban and Environmental Problems", *Am. J. Phys.* 38, 1244 (1970).

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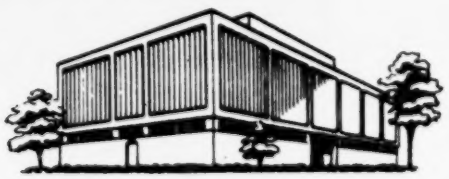

John R. Mayor, Director of Education
Richard G. Netzel, Acting Deputy Director of Education
Howard F. Foncannon, Associate Director of Education
William E. Chace, Editor

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this quantitative approach further. His course, "Technological Assessment," is aimed at "advanced undergraduates" from any field who have some background in and taste for mathematics. Quoting from the course description:

"A small number of simple concepts of physics and of analytical techniques arising from mathematical models used in physics will be developed through a wide range of typical applications. The concepts and models considered are among: order of magnitude estimation, energy, exponential growth and saturation, and analysis of distribution of random events. Application is made to cases among: biological populations, generation of energy, transportation systems. . . ."

Of course, one can't tell from topic headings what really goes on. But these two examples do seem to support the thesis that real physics can be taught within this new framework.

I believe that something else happens in these courses; "content" is relatively deemphasized and "process" is emphasized. By breaking up the highly sequential train of concepts, principles and laws that characterize our traditional introductory course, the environmental theme seems to make the instructor deal more with the search, the approach, the way of thinking and analyzing than with the bare facts of nature. And this is as it should be for the non-science student. (Do we also dare admit it would be good for the science, even the physics student?)

What does not come through from course descriptions is evaluation. What are the students expected to learn and what do they learn? In the seminars we would like to look at the student projects; in the courses we need to examine the examinations. Can the environmental theme be used to organize a course which leaves the student with some gain in the number and sophistication of the intellectual strategies which he will continue to employ, as well as with an accretion of facts? Again, one has at least the encouragement that he can do no worse than was done in the traditional course.

I hope that courses and seminars organized around the environmental theme will continue to proliferate. And I think that growth will occur in at least the following three categories: the supplementary seminars I have mentioned, the true environmental science courses which Goldberger called for and Marc Ross's course examples and, finally, the physical science for nonscience student course with an environmental theme. I am, as I have said, particularly hopeful that this last category will grow and that, from the experimentation in course content and style which is going on, will develop courses which are tuned more to the needs of today's students.

I am, in fact, anxious to do more than just hope that growth and experimentation continues. I am anxious to look for it. The SIPI Workbook *Environmental Education 1970* referred to earlier will need revision and added course descriptions. And further, there is a need within the physics community for exchange of course descriptions, textual materials and problems. This is a new focus for physics education. We will get little help from our present textbooks.

Since neither time nor ingenuity are in oversupply, a joint and cooperative approach to the design of courses, the construction of problems and the compilation of bibliographies is needed. Let me end this article with a call for course descriptions, syllabi, etc., and with an offer to see that this material is assembled, duplicated and made available to the profession. Please send these to me at the Commission address—University of Maryland, 4321 Hartwick Road, College Park, Maryland 20740. Your name will be on the first mailing list.

"On Saving Gullies"

"The fundamental principle in teaching that there is all the difference in the world between teaching subject matter as an end in itself and teaching it to solve problems of living was being observed in the breach. Gullies were being saved by words not by acts; gullies were recognized on the blackboard and not on lawns or farms. Teachers were saving curricular time, not land, water, minerals, animals and vegetation."—Paul F. Brandwein

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